CLAIRVOYANTE



# PenTile Overview

PenTile Overview

FAQ

**PenTile Basics**

One of the interesting things about the human vision system is the great extent to which the mind interprets what the eye sees. The eye, by itself, is not a great optical element. But, combine its' function of with the brain's interpretive skills and you have a powerful visual system. Clairvoyante believes that better application of this human vision system suggests new ways of delivering and processing display data that improves the overall performance of the panel.

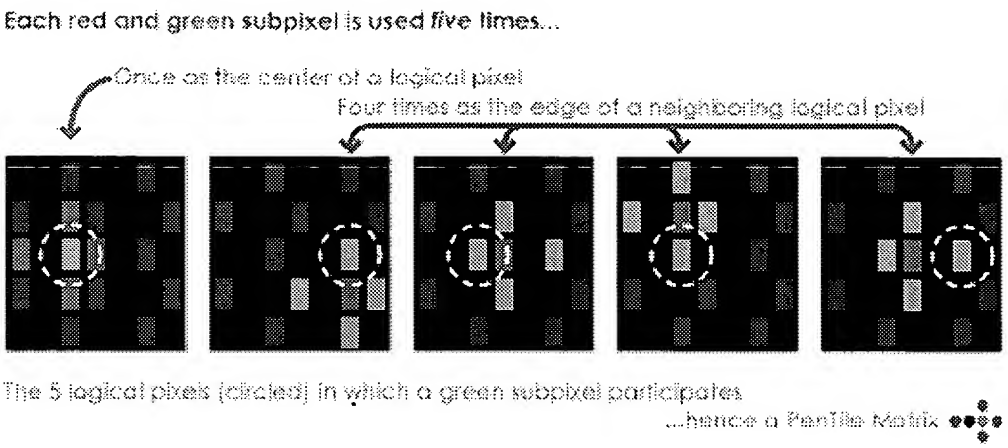
Clairvoyante studied the characteristics of the human visual system and its' perception of colored light then took advantage of those attributes to design the PenTile Matrix ?a set of optimal pixel architectures and image processing algorithms that can significantly improve panel performance.

The PenTile Matrix can dramatically increase the resolution and brightness of LCD panels without significant increase to the physical LCD materials cost or power consumption.

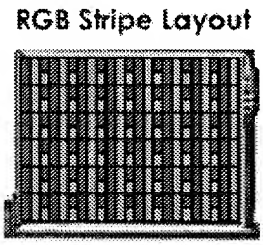
**Unbound Subpixels**

The PenTile Matrix leverages an optimized subpixel layout and controls color information with superior sub-pixel rendering algorithms. PenTile uses a set of advanced SPR algorithms to drive its unique pixel layout. With PenTile, color information is not organized into squares; rather, the algorithm places luminance information at each and every red and green subpixel, while filtering chromatic information at a lower resolution. This results in overlapping and additive 摘ifference of Gaussians?logical pixels and the ability to double the horizontal resolution of the panel without additional column drivers. This overlapping subpixel rendering scheme not only provides more resolution but it also delivers a better color balance due to the increased density of color information.

IDMC200.pdf




**The 4X Effect**




PenTile maximizes addressability - splitting subpixels vertically and rearranging the RGB color layout to deliver data more efficiently.

Humans perceive image quality as a combination of resolution, contrast, color balance and sharpness ?rapidly combining these visual attributes to create a perception of the image, video or object being viewed. Technically, image quality attributes are a result of addressability and Modulation Transfer Function Limit (MTFL). Addressability is the number of separate locations within a display on which a dot can be drawn. MTFL is the number of full color line and space pairs that can be displayed at the same time within a display.

Again, with PenTile, color information is no longer confined to the bounds of a square pixel. Instead, each red and green subpixel is a potential location for a dot of color - a capability enabled by advanced PenTile processing algorithms. This layered approach to subpixel rendering provides significant increases in the addressability and MTFL of the panel.

In fact, by simply increasing the number of row drivers and keeping a constant number of column drivers, PenTile doubles the MTFL limit and Addressability of any RGB Stripe panel - enabling a four-fold improvement in resolution with a fractional increase in physical LCD materials ?the 4X Effect.

**The Highest Resolutions at the Lowest Cost**

High performance panels cost less to build with the PenTile Matrix because it uses less physical components to more efficiently create a high-resolution image. In addition, PenTile enables existing a-Si plants and existing process to create high density panels - 300dpi and above ?that were previously impossible to create outside of LTPS

plants. A minimal increase in driver density delivers PenTile's 4X Effect and will allow numerous panel makers to produce high volumes of small screen, high resolution (qVGA, VGA, VGA+) panels to satisfy the needs of CE manufacturers and drive significant cost reductions in the process.

The table below compares various aspects of a qVGA RGB Stripe display and a VGA PenTile Matrix display. The table shows that the PenTile Matrix panel achieves 4X the resolution as the RGB Stripe panel with a small increase in the number of column drivers and twice the row drivers.

Notice the 4X the resolution increase over the RGB stripe panel with a mere 30% increase in total drivers.

| | 2.2" RGB | 2.2" RGB PenTile | Comparison |
|---|---|---|---|
| Panel Resolution | (240x320) | (480x640) | 4X |
| Horizontal MTFL (line pairs) | 120 | 240 | 2X |
| Vertical MTFL (line pairs) | 160 | 320 | 2X |
| Aperture ratio | 77.3% | 64.1% | -13% |
| Number column (data) drivers | 720 | 720 | 0 |
| Number row (select) drivers | 320 | 640 | +320 |
| Total number of drivers | 1040 | 1360 | +30% |
| Total number of pixels (K pixels) | 77 | 307 | 4X |
| total number of subpixels (K pixels) | 230 | 461 | 2X |
| Pixel clock (MHz) | 15 | 30 | 2X |

The addressability and MTFL of the second panel is double that of the first panel - delivering 4X resolution with minimal increase in physical LCD materials. The PenTile Matrix display costs less than a comparable high-resolution RGB Stripe display ?likely being built in an expensive LTPS plant.

**Increased Brightness and Reduced Power Usage**

On any display, there is a border area between each pixel and subpixel through which light cannot shine. The border area plus the active area equals the total area of the display. The proportion of the active area to the total area is the panel's aperture ratio.

In most LCD's, light is shined through the active area of a display at an intensity that creates the desired brightness for the panel. If the same amount of light is shone through a display with smaller openings and one with larger openings, the display with the larger openings will allow more light through the active area and will therefore be brighter.

As such, PenTile can be used to achieve a larger aperture ratio at the

same resolution as an RGB stripe panel - significantly increasing panel brightness with a back light intensity that is equal to the RGB panel.

Comparing a qVGA RGB Stripe panel with a qVGA PenTile will illustrate the concept?

| | 2.2" RGB | 2.2" RGB PenTile | Comparison |
|---|---|---|---|
| Panel Resolution | (240x320) | (240x320) | Equal |
| Horizontal MTFL (line pairs) | 120 | 120 | Equal |
| Vertical MTFL (line pairs) | 160 | 160 | Equal |
| Aperture ratio | 77.3% | 86% | +8.7% |
| Brightness | 100% | 111% | +11% |
| Number column (data) drivers | 720 | 360 | -400 |
| Number row (select) drivers | 320 | 320 | 0 |
| Total number of drivers | 1040 | 680 | -38% |
| Total number of pixels (K pixels) | 77 | 77 | Equal |
| total number of subpixels (K pixels) | 230 | 115 | -50% |
| Pixel clock (MHz) | 15.2 | 7.6 | -50% |

Power usage is related to the amount of electricity needed to drive an LCD backlight and the power needed to run physical driver circuitry for delivering the RGB data to the panel. A higher aperture ratio means that backlight intensity can be decreased while still achieving the same brightness levels. Using fewer subpixels reduces physical circuitry demands - limiting the maximum operating frequency of the panel, lowering power requirements and reducing electromagnetic interference (EMI).

**Increased brightness RGBW PenTile**

Further brightness gains are possible with Clairvoyante PenTile RGBW. Taking advantage of the human visual system's lower sensitivity to blue, new PenTile RGBW layouts and algorithms minimize the blue subpixel elements and replace them with white. These developments can lead to a doubling of brightness for high resolution displays. Prior to PenTile RGBW, multi-color technology required additional subpixels to add brightness, which resulted in higher costs. The PenTile approach, with its more efficient use of subpixels, can be combined with RGBW technology to further increase brightness.

The following table shows the impact of RGBW combined with PenTile layouts. Not only is 4X Effect achieved but brightness is actually improved versus the RGB Stripe panel at _ the resolution.

| | 2.2" RGB | 2.2" RGBW PenTile | Comparison |
|---|---|---|---|
| | | | |

| Panel Resolution | (240x320) | (480x640) | 4X |
|---|---|---|---|
| Horizontal MTFL (line pairs) | 120 | 240 | 2X |
| Vertical MTFL (line pairs) | 160 | 320 | 2X |
| White Transimission (%) | 6% | 6.6% | +10% |
| Number column (data) drivers | 720 | 720 | 0 |
| Number row (select) drivers | 320 | 640 | +320 |
| Total number of drivers | 1040 | 1360 | +30% |
| Total number of pixels (K pixels) | 77 | 307 | 4X |
| total number of subpixels (K pixels) | 230 | 461 | 2X |
| Pixel clock (MHz) | 15 | 30 | 2X |

**Ease of Implementation**

PenTile is easy to implement with existing manufacturing process and materials. The PenTile Matrix architecture is implemented by changing the subpixel size and color layout during the color printing process. PenTile processing algorithms can be implemented either in the software or hardware. In both cases, only minor changes are required from existing reference designs.

Home | Licensing | Developers | Corporate
Site Map | Contact Us